

PROGRAM NOTES AND ABSTRACTS FOR WEEK 1

Apprentice Program: Daniil Rudenko

We will cover a variety of topics in algebra, geometry and combinatorics. More details will be given Monday morning.

Probability: Yier Lin

TITLE Introduction to large deviations

ABSTRACT: The law of large numbers, central limit theorem and large deviations are three pillars of the modern probability theory. The goal of the lecture is to explain what large deviations are. I will start with elementary examples (such as coin flipping) and explore the general theory of large deviations behind.

Analysis: Greg Lawler

TITLE: Fractal measures and dimension

ABSTRACT: There are many sets whose effective “dimension” is not an integer. Benoit Mandelbrot coined the word “fractal” to describe these sets. The word fractal is not a precise term but there are precise mathematical ideas that describe this kind of behavior. In the first week, I will introduce precise notions: Minkowski (or box) dimension, Hausdorff measure, Hausdorff measure, and (if time permits) Minkowski content measures. In later weeks I will be discussing some random fractals and that material will build on these lectures, but this week I am focusing on deterministic (nonrandom) sets.

Number Theory: Zilian Luo

TITLE: Riemann’s explicit formula.

ABSTRACT: Prime numbers hold a significant allure within the realm of mathematics due to their mysterious nature. We will explore the connection between the prime counting function and the zeros of the Riemann zeta function through the explicit formula of Riemann.

Geometry: Aaron Calderon and Ben Lowe

TITLE: Hyperbolic geometry and low-dimensional topology

ABSTRACT: Hyperbolic geometry is of fundamental importance in low-dimensional topology. We will give a crash course on hyperbolic geometry and then move to some topics of current interest, possibly including the connection between circle packings and Kleinian groups.

Algebraic Topology: Peter May

Two topic series, one more elementary than the other

Title: Finite spaces and larger contexts

Abstract: A finite space is a topological space with finitely many points. Finite spaces are “isomorphic” to finite posets and “equivalent” to finite simplicial complexes. They relate well to categories, simplicial sets, and general topological spaces. They are entering the applied world through data analysis and discrete Morse theory, and they are intrinsically related to many areas of current mathematical interest. We will start slow and go as far as we can. As an easy miracle, we will see a space with six points and infinitely many non-zero homotopy groups.

Title: Operads and iterated loop spaces

Abstract: This is an area a half century old that is undergoing current reinvestigation on a more abstract and yet quite concrete level. We will explain the interest of higher homotopical structure and show how simply it can be incorporated into elementary structures which hide the homotopies conceptually. Spectra and stable homotopy theory will be introduced. The focus will be on the process of constructing iterated loop spaces and spectra from structured spaces and categories, getting into equivariant and multiplicative contexts as and if time permits.